

**Laser Industrial Partnership Program**

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p.6**Abstract**

In conjunction with the Space Application Industrial Laser System (SAILS) program, CSTAR has developed a terrestrial program for transfer of laser materials processing technology to U.S. industry. This program, called the Laser Industrial Partnership Program (LIPP), combines state-of-the-art laser laboratory facilities, a multi-disciplinary group of scientist/engineers, and the technology acquired through the SAILS program to assist in application of lasers to manufacturing.

This program is a joint effort between CSTAR and the Center for Laser Applications at The University of Tennessee Space Institute.

The purpose of this report is to describe the strategy used in developing the program and to detail the main industry projects accomplished during FY 1992.

**Introduction**

One of the objectives of the NASA Centers for Commercial Development of Space is to develop commercial space products/processes which are also beneficial for ground applications. In the current economic environment, most U.S. industries are hard pressed to commit to long term commercial space development without some short term market benefits. The SAILS program provides a viable long term space application through development of a multi-purpose laser repair and fabrication workstation for Space Station Freedom and other permanent space platforms.

The LIPP program provides immediate commercial benefit through implementation of the laser materials processing technology developed through the SAILS program to U.S. industry for application to current products/processes. This is accomplished by providing a uniquely unbiased resource to industry.

Traditionally, an industry interested in lasers for manufacturing has two resources available for

technical assistance: 1) laser companies, and 2) laser job shops. 1) The laser companies often bias their recommendations toward their specific product line when an alternative process may be more appropriate for the application. In addition, these companies usually cannot devote adequate time for a thorough evaluation of the process. 2) The laser job shops are usually neither equipped nor staffed to provide technical development of a new laser product/process.

CSTAR/UTSI applies a multi-disciplinary approach to each industry requirement in an effort to identify the appropriate manufacturing technique for that particular product. This unbiased approach provides a service not currently available to industry.

**1992 LIPP Objectives and Marketing Plan**

This program, initiated in November 1991, has the objective of assisting industry in the application of laser materials processing technology to improve their manufacturing processes. The use of lasers by U.S. industry has been slow in developing when compared to Europe and Japan. This has contributed to the

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decline in the global U.S. manufacturing market segment. By implementing laser technology, U.S. industry can improve the quality and production efficiency of their products, thus enhancing the global U.S. competitive position.

To implement these program objectives the following phases were identified for 1992:

- Phase 1: Develop marketing materials describing the CSTAR/UTSI laser materials processing capabilities.
- Phase 2: Identify the segment of industries to approach and develop a list of prospective companies.
- Phase 3: Contact these industries through mailings, conferences, and personal references.
- Phase 4: Schedule visits to individual companies for survey of the manufacturing floor. Arrange laboratory demonstrations at CSTAR.
- Phase 5: Develop and perform laser processing projects with industries.
- Phase 6: Evaluate progress and revise each phase as required.

#### 1992 Progress

Progress for the first year of this program will be reported in two sections: Marketing Program (Phases 1, 2, and 3), and Industry Projects (Phases 4 and 5).

#### **Marketing Program**

- Phase 1: A marketing brochure was developed in-house in early 1992. This four color brochure displays the laser materials processing facilities at CSTAR/UTSI along with the services offered through the program to industry.

In addition, a marketing booth was purchased in April and display materials were developed for both laser materials processing and other CSTAR focus areas for use at the May TABES exhibition in Huntsville.

Phase 2: A list of approximately 150 potential industries was compiled from the following sources:

- Tennessee and Alabama industrial directories
- TVAR regional industry list
- CSTAR/UTSI industrial contacts
- Laser industry contacts

These industries were separated into high and medium prospect categories based on project probability.

- Phase 3: The high prospect industries (approximately 25 companies) were contacted initially by mail with phone followup. The remaining industries have been cataloged and will be contacted in early 1993. The strategy for targeting the high prospects has proven beneficial as described in the next section.

#### **Industry Projects (Phases 4 and 5)**

The following describes each of the industry projects accomplished during 1992 through the LIPP program:

##### YAG Laser Generator Repair System Siemens Nuclear Power Services

Siemens Nuclear is developing a YAG laser repair system for welding of Inconel tube sleeves into damaged steam generator piping. This system requires state-of-the-art optics and fiber beam delivery systems. During the period from March to the present, CSTAR has provided assistance in

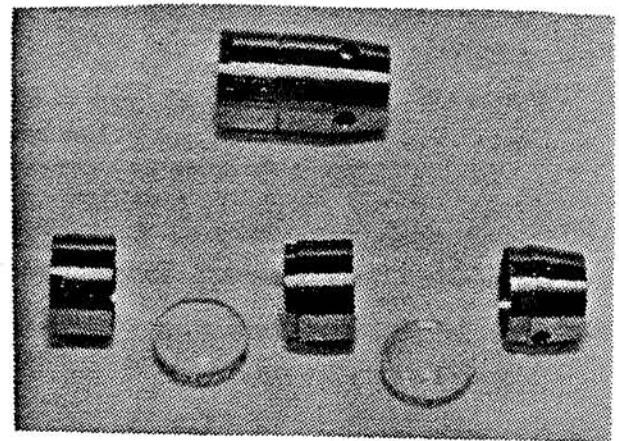


**Figure 1** Lens assembly for Siemens laser welding system.

development and fabrication of the optical end effector (see Figure 1) and fiber housing systems. In addition to the laser system, CSTAR developed a technique for laser joining of thermocouples to the Inconel piping for thermal analysis of the joining process (see Figure 2). Siemens has used this

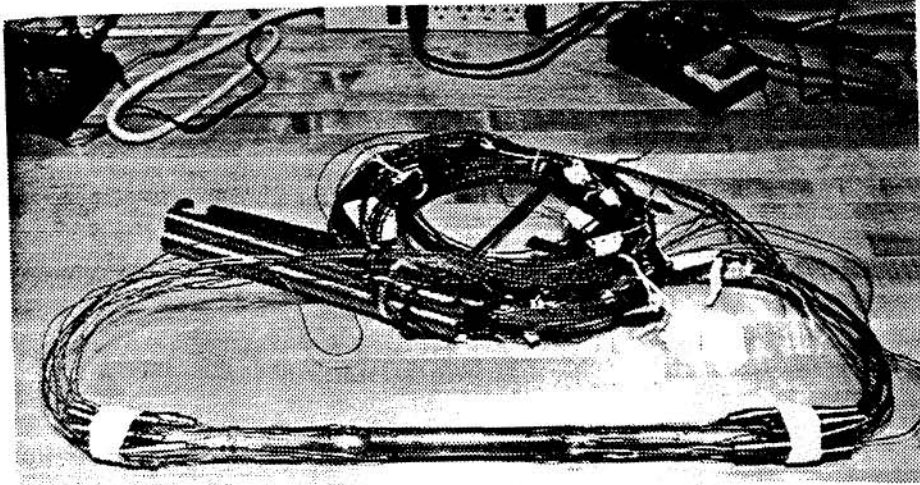


Figure 2 Test section of 3/4" Inconel piping with 24 laser-welded thermocouples.

process to validate the structural integrity of the sleeving procedure. As of this date, the laser sleeving system is nearing completion at Siemens and will become only the second of its kind in the world.

#### Inconel Clip Assembly Spot Welding Siemens Nuclear Power Services

After receiving the LIPP marketing information, Siemens requested that CSTAR submit a proposal for development of the process to laser weld Inconel springs onto nuclear refueling clip assemblies. These assemblies are used in nuclear facility maintenance where weld reliability is critical. In the past this work has been provided by laser job shops, resulting in varying weld reliability.

CSTAR submitted an interest and feasibility statement outlining the general requirements for this type of laser system, which would consist of a YAG laser, two axis workstation, and vision positioning system. Following analysis by Siemens, CSTAR was informed that the information was very beneficial for planning by their manufacturing division and that further development would be budgeted for 1993.

#### Laser Manufacturing of Thermos Components Aladdin Industries

At the recommendation of the SAILS industrial partner, Lumonics, CSTAR contacted Aladdin about determining the feasibility of using lasers for hermetic welding of stainless steel thermos containers. Conventionally, this process is performed by TIG and resistance welding techniques which result in a scrap rate of 10% due to non-hermeticity at the joint. A survey of the manufacturing facility was conducted by CSTAR and revealed that commercial laser suppliers had pressured Aladdin toward the use of CO<sub>2</sub> lasers without considering other possible options.

CSTAR conducted preliminary welding experiments using the Lumonics JK701 YAG laser and produced high quality hermetic welds at the critical joint areas. (See Figure 3). These welded samples along with an economic appraisal of the required system was submitted to Aladdin. Based on this information, Aladdin has selected YAG for the production laser system and is currently soliciting suppliers for the complete system.

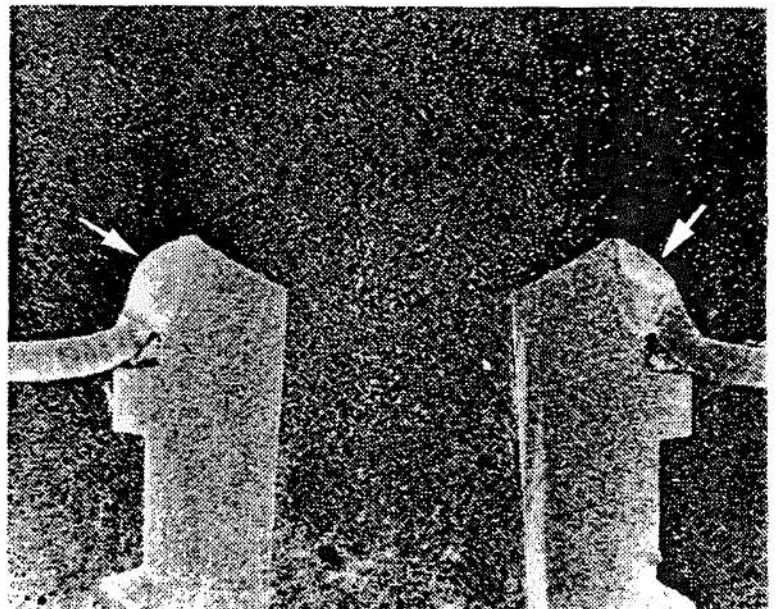


Figure 3 Cut section of laser welded thermos assembly.

Development of Transmission Bellows Assembly  
Robert Shaw (Johnson Technologies)

Production of an automotive transmission altitude-correction bellows assembly by Robert Shaw is typically performed by a manual brazing process. This process is time consuming and does not always produce the required hermetic seal. CSTAR was contacted by Johnson Technologies to design and fabricate a prototype assembly using laser technology to replace this brazing process. Working with Johnson and Robert Shaw, several design and materials concepts were developed and welded using the CSTAR Lumonics YAG laser. Some of the bellows components used during the evaluation are shown in Figure 4. The main objective was to

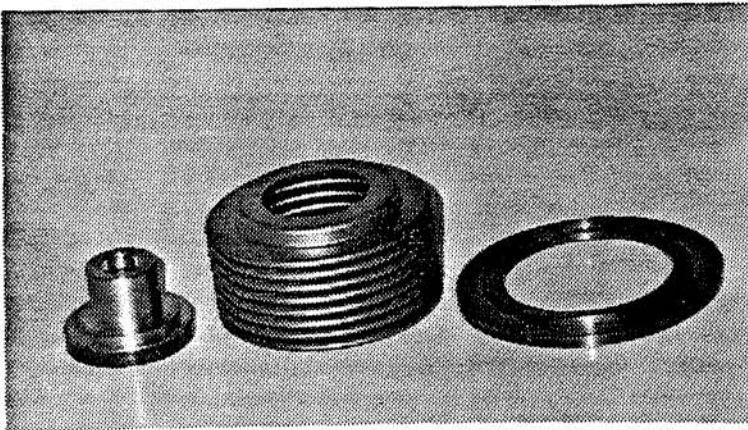


Figure 4 Automotive transmission bellows components.

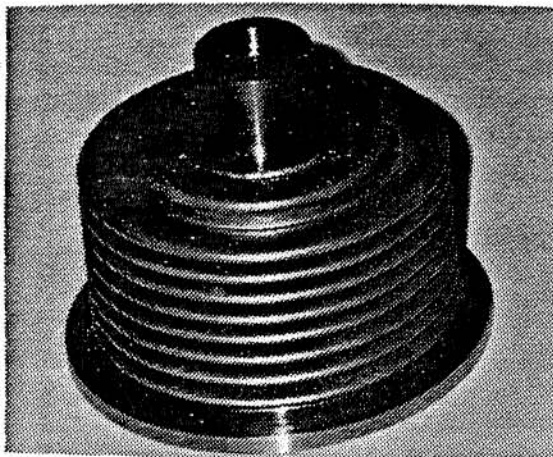


Figure 5 Laser welded bellows assembly.

produce a hermetic seal at the joints shown in Figure 5. After several prototype designs were attempted, hermeticity was achieved and a complete assembly was submitted to Robert Shaw for analysis. Based on the results of this project, Robert Shaw is considering implementing a production laser system next year.

Laser Drilling of Wire Blanks  
Lukens Medical Corporation

Drilling of blind holes in 304 stainless steel blanks is required in the process of fabricating surgical products. These holes have aspect ratios (length/diameter) ranging from 6.5 to 26.0. Currently this drilling process is performed outside the United States using laser technology and returned to Lukens for finishing. This arrangement has proven uncontrollable for Lukens resulting in shipment delays, poor quality control, and high production costs. Relocation of this process to the Lukens facility could alleviate many of these problems and provide a higher quality, lower cost product. CSTAR has been approached to provide technical assistance in developing this laser process for Lukens.

Following an initial meeting at CSTAR, several sample blanks were drilled using the YAG laser and submitted to Lukens as proof of concept. Further technical discussions identified two steps for implementation of a laser drilling system at Lukens:

Step 1: Establish the feasibility for production of laser drilled wire blanks through the following tasks:

- Optimize the laser parameters for the required hole specifications through laboratory experimentation.
- Determine hole quality through structural and metallurgical analysis.
- Identify equipment requirements and cost.
- Evaluate utilization of the CSTAR laser facilities for prototype batch production.

Step 1 would provide a comprehensive analysis of lasers for this application at a minimum investment by Lukens.

Step 2: Development of the production laser system and installation at the Lukens manufacturing facility.

A draft proposal detailing these steps was submitted to Lukens in August. Response has been positive with funding budgeted by Lukens for the project to begin in late 1992.

#### Laser Texturing of Prosthetic Implants XYZ Medical Company

At the suggestion of Lumonics, CSTAR contacted XYZ concerning the use of laser technology for the manufacture of prosthetic implants. These titanium components require complex machining and finishing operations to accurately reproduce damaged knee and hip joints.

The surface finish of the components can greatly effect the stability of the implant due to the interaction with the surrounding bone. A finish which would allow the bone to grow into the component could greatly enhance stabilization of the implant. Currently, a contractor is employed to manually place 0.005" diameter beads onto the component and then perform a sintering process to complete the finish. XYZ has reported that this process does not provide the stability nor spacing necessary to produce the desired finish.

CSTAR and XYZ have jointly conceived the concept for laser drilling holes into the component which would allow the desired bone growth to occur. A proposal is currently being developed at CSTAR for determining the feasibility of this concept through experimental, metallurgical, structural, and economic analysis. XYZ has agreed to this concept in principle and anticipates funding the project in early 1993.

#### Laser Cutting of Semi-Conductor Ceramics Physitron, Inc.

From a TVAR referral, CSTAR contacted Physitron to offer assistance with a ceramic cutting application. This manufacturer of semi-conductors was interested in conducting radiation testing of electrical components. Due to the design of the chip, it would be necessary to remove a 0.32" x 0.34" section of alumina ceramic material covering the electrical materials. In addition, the cut was required to maintain a tolerance of  $\pm 0.010$ " due to the location of sensitive semi-conductor components. These constraints make it difficult for most machining operations to remove the material without affecting the surrounding components. CSTAR identified the YAG laser as the appropriate tool and, through drill

trials, determined the correct parameters for this machining operation. The final product was machined by CSTAR and returned to Physitron within the specified tolerances.

#### Industrial Laser Teaming Program Micro Craft Incorporated

Previous discussions between CSTAR and MICRO CRAFT had revealed the following compatible interests in laser materials processing:

##### **CSTAR:**

- Transfer the laser materials processing technology available at CSTAR/UTSI to U.S. manufacturing industries.
- Develop teaming relationships with industry to increase CSTAR equipment and manpower capabilities.
- Acquire additional industrial sponsorship for the SAILS flight program.

##### **MICRO CRAFT:**

- Expand the MICRO CRAFT equipment and capabilities portfolio to include laser materials processing.
- Develop the expertise and determine the extent and nature of the laser materials processing market before investing in a complete laser facility.

The concept of combining the resources and expertise of CSTAR with some additional equipment and an applications engineer by MICRO CRAFT was developed from these discussions. CSTAR has submitted a proposal to MICRO CRAFT detailing options for the laboratory modifications and personnel requirements for this teaming relationship.

#### Laser Welding of Dissimilar Alloys Rocketdyne

Rocketdyne is interested in developing the technologies for laser welding of dissimilar, reflective alloys. Candidate designs for new rocket combustion chambers involve fabrication of laser welded joints for liners, closeouts and manifold rings. These involve a combination of alloys for which very limited weldability data is available. The ability to join these alloys will present opportunities to reduce

fabrication costs on aluminum structures found on SSF and other lightweight hardware.

Rocketdyne has committed to cost sharing with CSTAR in the investigation of techniques required to join these dissimilar materials. The project is scheduled to begin in November 1993.

#### **Future Work (Program Phase 6)**

##### **Marketing**

As described in Program Phase 6, the marketing effort is to be evaluated at the end of the year to refocus toward the most successful methods and revise the marketing materials as necessary. Based on the 1992 results, the most successful industry relationships were established from recommendations by CSTAR affiliates and will be one of the main methods for marketing during 1993. In addition, it was observed that the nuclear and medical industries have applications which are particularly suited to laser technology. These industrial areas will also be targeted during 1993.

##### **Industry Projects**

It is anticipated that the open industry projects described in the 1992 Accomplishments section of this report will be continued during the coming year.

#### **Conclusion**

This laser materials processing technology transfer program has been successful in both identifying and implementing a marketing strategy. The work accomplished in 1992 and projects anticipated for 1993 demonstrate the concept as a viable commercialization program. As a result of LIPP, several manufacturing industries are currently involved in implementing laser processing technology in their facilities.

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